"Continuity, complexity and emergence: what is real for digital designers?"

CONTINUITY, COMPLEXITY AND EMERGENCE: WHAT IS THE REAL FOR DIGITAL DESIGNERS?

REALITY AND THE REAL

Reality versus the real – despite their difference, these two words are often confused with one another. Their apparent interchangeability calls for an immediate clarification. In this article, I will distinguish between reality and the real in the field of architecture in a way reminiscent of Immanuel Kant's distinction, exposed in his *Critique of Pure Reason*, between phenomena and noumena, that is between objects and events as we perceive them and objects and events as they truly are. Here, reality will be about the world as perceived, whereas the real will designate the world envisaged independently from us, or as the original source of what appears to us. But why mobilize such a distinction, especially when dealing with digital design and its claim to be realistic? For contemporary designers to be realistic usually means to be in accordance with ordinary reality, to be plugged into the dense texture of the world as we perceive it rather than to relate to some deeper level that may be disconnected from physical experience. Here, I will argue that the need for such a distinction arises from the difficulty of assigning a clear scope to architecture as an artistic or, more broadly, a cultural production. Confronted with this difficulty the architectural discipline has consistently tried to convey something about the underlying structure that allows phenomena to appear to us. Contrary to Kant who postulated the unknowable character of noumena, designers tend to believe that it is possible to express some of their properties, at least in architectural terms. Whereas philosophy has to stop at some point, because of the limitations inherent to language; architecture claims that it can carry on thanks to its intimate relation with matter.

For a postructuralist historian there is, of course, no totally objective and atemporal real. Like reality, the real, or rather what we assume it may be, is to a large extent a cultural construction dependent on various historical and social conditions. In such a perspective, the history of architecture reveals the existence of a series of conceptions of the real, from the Vitruvian belief in an architectonic order ruling the world to more contemporary versions of such underlying principles of organization. The present article is devoted to one of the most recent versions of the real, namely the one that has been conveyed by digital design from the early 1990s on. The development of digital architecture is indeed inseparable from a number of fundamental assumptions regarding what constitutes the world. Despite important variations from one protagonist of the story to another, one is nevertheless struck by the convergence of their intuitions regarding some of the fundamental characteristics of the real.

Although very recent, this quest for the real signals a new episode in a long history. This history is rooted, as I said, in the enduring difficulty to define the objectives of architecture beyond the immediate usefulness of buildings. As an artistic production, architecture has always had more trouble identifying its core principles than the other fine arts. For a long time, this difficulty was interpreted within the framework provided by the dominant theory of imitation. Contrary to painting or sculpture, architecture did not directly imitate the forms of nature. Its true scope and meaning were to be found elsewhere, at a deeper level, where the laws of nature met with those of spatial order and proportion. Such was the belief expressed throughout the early modern period by theorists and practitioners claiming inspiration from Vitruvius. Most of them would have readily subscribed to French theologian Jacques-Bénigne Bossuet's statement that God had created the world like an architect by giving it order and proportion.[1] This belief also explained the interest taken by many of them in the proportions allegedly given by

[1] Jacques Bénigne Bossuet, *Introduction à la Philosophie, ou de la Connaissance de Dieu, et de Soi-Mesme* (Paris: R.-M. d'Espilly, 1722), p. 37-38.

God to the Temple of Jerusalem.[2] ILL 1 More than anything else, these proportions were seen as a direct expression of the real as opposed to mere experiential reality.

Although twentieth-century artistic evolution has led to the abandonment of the theory of imitation, the identification of the proper scope of the architectural discipline has remained a problem. Architecture does not usually reach the same degree of expressive evidence as other arts. Its low-key expressiveness is often equated with a blurred agenda in which utilitarian concerns obscure other types of preoccupations. But despite all the attempts made to "deconstruct" the discipline and its productions, there is something that remains distinctively foundational in architecture, something that seems to point towards a layer located beneath immediate experience, towards a kind of substratum that makes sensory reality possible. Such a substratum has probably to do with the body envisaged as the structure that transforms sensory experience into a coherent whole. It represents the ultimate level of reality we can have access through sensory intuition, hence the temptation to consider it as a close approximation of the real.

Thus, the question of the real in architecture is both elusive, even risky insofar that it may appear unnecessarily idealistic, and unavoidable as a means for the discipline to justify its claim to cultural relevance. In order to avoid the idealistic turn, a possible interpretation of what the real is truly about is to consider it as the most fundamental level at which architecture relates to the social imaginary. As an artistic and cultural production, architecture clearly has to do with the social imaginary, that is to say the various shared references with which a given society builds a common frame of understanding for the problems that matters to it. Architecture's play with the social imaginary counterbalances its fundamentally abstract character. Even if Jean Nouvel's Institut du Monde Arabe in Paris represents nothing specific, its façade conveys an

[2] See Joseph Rykwert, *On Adam's House in Paradise: The Idea of the Primitive Hut in Architectural History* (New York: Museum of Modern Art, 1972).

impression of déjà-vu that relates simultaneously to images of Islamic architecture moucharabies, giant camera aperture mechanisms and computer chips. ILL 2

As its name suggests, images, let them be visual or rhetorical, play a decisive role in the social imaginary. But following the Greek philosopher Cornelius Castoriadis, it is simultaneously possible to doubt whether they represent its true foundation. For Castoriadis, the social imaginary is ultimately organized around figures, or rather structures that have to do with basic intuitions regarding, for instance, space and time.[3] The real that we are envisaging here can be defined as the world that is aimed at by these intuitions.

Despite their central role in the overall organization of the social imaginary, these intuitions do not necessarily correspond with what common sense may suggest. To the contrary, at the core of the social imaginary, they often represent a disturbance to what everyday experience suggests. The real is not only supposed to be the foundation of reality; it also epitomizes its capacity for change.

When architects try to say something about this world by other means than their projects, they often use scientific and philosophical references.[4] Contemporary digital designers will for instance readily mention dynamic systems theory or Gilles Deleuze's philosophy. Beyond the affectation and the various misunderstandings that undermine many of these attempts to relate to science and philosophy, they are nevertheless important for the architectural discipline insofar as they bring it back to the question of the roots of everyday reality. Architecture cannot simply be realistic; it has to come to terms with its ambition to deal with the real.

---

[3] See in particular Cornelius Castoriadis, *The Imaginary Institution of Society* (Paris, 1975, English translation Cambridge, Massachusetts: MIT Press, 1998).

[4] Cf. Antoine Picon, "Architecture and the Sciences: Scientific Accuracy or Productive Misunderstanding?", in Akos Moravanszky, Ole W. Fischer (eds.), *Precisions: Architecture between Sciences and the Arts*, (Berlin: Jovis, 2008), p. 48-81.

A CONTINUOUS WORLD

The most fundamental feature of the real to which digital designers refer explicitly or implicitly is its continuous character. It is striking to observe how this feature was already present in the reflections of Greg Lynn a few years before he turned to the computer. Claiming its inspiration from Deleuze's celebrated essay, *The Fold: Leibniz and the Baroque*, his 1993 manifesto on "folding in architecture" advocated continuity, smoothness and curvilinearity as an alternative to the fragmented and conflicting approach followed by deconstructivist architecture.[5] ILL 3 Behind this formal orientation lied the belief in a world of continuous variations that led from one thing to its contrary. From early blobs to recent parametric design, digital architecture has faithfully followed this agenda of "smooth transformation involving the intensive integration of differences within a continuous yet heterogeneous system."[6] Even if the reading of his work was often superficial, to say the least, Deleuze represented a crucial reference for the advocates of smoothness insofar that his philosophy could be interpreted "as a vast hermeneutic of continuity,"[7] to use Mario Carpo's retrospective characterization of the folding moment in architecture. Besides Deleuze's philosophy, scientific theories like topology and morphogenesis also represented crucial references for Greg Lynn and his colleagues. ILL 4

That the folding moment came before the computer, and yet defined on a long term basis the use of digital tools in architecture is telling of the limits of technological determinism. Following Carpo again, one has to admit that "computers per se do not

---

[5] Gilles Deleuze, *The Fold: Leibniz and the Baroque* (Paris, 1988, English translation Minneapolis: University of Minnesota Press, 1993); Greg Lynn, "Folding in Architecture", *Architectural Design*, (London, 1993, revised edition London: Wiley-Academy, 2004).

[6] "Architectural Curvilinearity: The Folded, the Pliant and the Supple", in Greg Lynn (ed.), *op. cit.*, p. 24-31, p. 24 in particular.

[7] Mario Carpo, "Ten Years of Folding", in Greg Lynn (ed.), *op. cit.*, p. 14-19, p. 14 in particular.

impose shapes, nor do they articulate aesthetic preferences."[8] Digital architecture is not the mere consequence of the introduction of digital technological in the design field from the mid-1990s on. It appears rather as the result of the convergence between an evolution of the discipline influenced by culture at large and the new possibilities opened up by computerization.

Another way to distance oneself from technological determinism is to observe the gap, even the discrepancy, between the fundamentally discontinuous nature of digital procedures and the way they have been mobilized by architects to convey the intuition of a continuous real. Whereas digital music is synonymous with the substitution of discrete signals for continuous modulation, digital architecture seems to proceed the in the opposite direction. The "elegant" forms advocated by theorists and designers like Ali Rahim or Patrik Schumacher are indeed based on transitions rather than jumps.[9]

Now, this does not necessarily mean that digital music is more in accordance with today's prevailing conception of the real than architecture. For the discrete coding implied by the use of digital tools is no longer related to the epistemological assumption that the world follows the same discrete steps. The new direction taken by contemporary life sciences epitomizes this evolution with the various critiques addressed to the interpretation of the brain as a giant computer, that is to say, a discrete state machine following the model established by Turing, and the important caveats brought to the understanding of DNA as pure information. Life sciences are indeed emblematic of the possibility of obtaining all sorts of results through procedures analogous to coding and decoding, while recognizing that the notion of code is inadequate to characterize what nature truly does. Digital architecture seems to echo such an approach; with its smooth transitions negotiated with the help of the computer, it produces forms that cannot be reduced to the codes from which they are derived.

---

[8] *Ibid.*, p. 16.
[9] Ali Rahim, Hina Jamelle (eds.), "Elegance", *Architectural Design*, January-February 2007.

To live in a continuous world presents far-reaching implications. They concern the notion of space, the way objects must be conceived as well as the relation between the human subject and his/her environment. First, space can no longer be apprehended as a passive container. Far from being passive, it appears animated by fields, gradients and flows in a way that tends to blur the distinction between the non-organic and the organic. In today's real, continuity goes with a pervasive animation that is no longer the monopoly of organic life. ILL 5

These fields, gradients and flows generate local maximums and minimums as well as provisory assemblages. Local maximums and minimums produced by processes such as inflection, the mathematical operation behind folding, assemblages reminiscent of Gilles Deleuze's rhizomes or Bruno Latour's hybrid networks: these are the new structural entities that constitute the real today. This implies a fundamental shift in the way we must think of objects. Whereas traditional objects had a tendency to stand in splendid isolation, these new entities are never completely separable from their surrounding conditions.

That digital architecture has to do with such a conception may seem paradoxical at first given the hyper formalistic character of many of its productions, from Zaha Hadid's Phaeno Center to Asymptote's HydraPier. ILL 6, 7 But the concern with form displayed by many contemporary designers is often accompanied by the simultaneous abandon of any kind of belief in its potential perfection. Nothing is more opposed to digital formalism than Platonic idealism. One of the reasons for that lies in the fact that modeling software and its underlying calculus-based frame usually produces a continuous series of surfaces and volumes, something more akin to a geometric flow or film obtained from direct deformation or parametric variation than to a fixed configuration. In such a context, form appears as a moment in a flow, or a still produced by freezing the moving geometry. Far from floating in the realm of pure ideas, it is inseparable from its computer-aided process of production.

Among the consequences of this new situation, one finds the possibility of considering form as something that happens, as an occurrence or an event, rather than a static substance. This possibility might very well lie at the core of today's tendency to interpret architecture as a performing art.[10] Beyond any kind of technological performance, beyond its effect or rather the affect it provokes, what contemporary architecture does is to emerge as an instance in a theoretically unlimited set of possibilities revealed by computer modeling and parametric design.[11]

The formal obsessions of digital design and its simultaneous distantiation from the traditional conception of architectural form as a substance converge on the new importance given to surface. More than volumes, surfaces seem to bear the mark of the computer processes that generate them, a point made clear by Georges Liaropoulos-Legendre in his essay *ijp: The Book of Surfaces*.[12] Whereas volumes seem arbitrary and by the same token somewhat opaque and inert, surfaces appear as more genuine expressions of parametric variations. In other words, surfaces are more naturally animated. ILL8

Surfaces also seem to challenge the sharp difference traditionally articulated between the architectural object and its surroundings. This explains the recent multiplication of projects that blur the boundary between architecture and ground, architecture and landscape, a trend exemplified by realizations such as Renzo Piano's Paul Klee Museum in Bern, Switzerland, Odile Decq's Liaunig Collection Museum in Neuhaus, Austria, or Vicente Guallart's Denia Cultural Park in Spain.

---

[10] See for instance Branko Kolarevic, Ali M. Malkawi (eds.), *Performative Architecture: Beyond Instrumentality* (New York, London: Spon Press, 2005).

[11] We have explored this question in more details in Antoine Picon, "Architecture as a Performative art", in Yasha Grobman, Eran Neuman (eds.), *Performalism. Form and Performance in Digital Architecture* (Tel Aviv: Tel Aviv Museum of Art, 2008) p. 18-23.

[12] Georges Liaropoulos-Legendre, *ijp: The Book of Surfaces* (London: Architectural Association, 2003).

The privilege given to surfaces is also related to the last and probably most essential consequence of a continuous real, namely the need to overcome the notion of a clear-cut separation between the human subject and the non-human things that surround him/her. In many contemporary projects, architectural skin is meant to speak immediately to the senses in an almost haptic manner that leaves the subject unclear about where his/her sensitive self ends and from where exterior reality truly takes over.[13] Through practices often deemed as "ornamental", digital architecture's approach to the surface or the skin relates to the importance of sensation, or rather sensorium, understood as a holistic continuum that bridges the gap between affects and their cause.[14] In such a perspective, traditional architectural presence is replaced by a pervasiveness of affect that is even more disconcerting for the layman than the strange shapes of alternative digital geometries.

Besides Gille Deleuze's writings, Bruno Latour's essays represent another set of key references for those who try to understand what the continuity between the human and the non-human means today.[15] More recently, in Europe at least, Peter Sloterdijk's philosophy of interiority has begun to permeate the discourse of designers for similar reasons. The first volume of his *Spheres* trilogy insists indeed on the fact that one has to consider subjectivity as a spatial phenomenon that extends beyond the boundary of the body.[16]

The connection between digital architecture and the conception of a human subject in continuity with his/her environment should not come as a surprise insofar that it actually represents one of the threads that links the early stages of computer culture to the present digital age. The theme had already been explored by cybernetics. In

---

[13] See on this question Andrew Payne, "Surfacing the New Sensorium", in *Praxis. Journal of Writing+Building*, n° 9, 2007, p; 5-13.

[14] Cf. Farshid Moussavi, Michael Kubo, *The Function of Ornament* (Barcelona: Actar, 2006); Ali Rahim, *Catalytic Formations: Architecture and Digital Design* (London and New York: Taylor and Francis, 2006).

[15] See for instance Bruno Latour, *We Have Never Been Modern* (Paris, 1991, English translation Cambridge, Massachusetts: Harvard University Press, 1993).

[16] See Peter Sloterdijk, *Bulles: Sphères 1* (Frankfurt, 1998, French translation Paris: Hachette, 2003).

particular, Gregory Bateson's 1973 book *Steps to an Ecology of Mind,* was already challenging the traditional notion of human interiority.[17] In direct connection with the design world, some of his key arguments have recently been reformulated by William Mitchell in his essay *Me++: The Cyborg Self and the Networked City* in which he evokes the partial delocalization of the nervous system through electronic means.[18] ILL9

From an animated space to distributed sensorium and even subjectivity, one may wonder what the belief in continuity represents in practice for designers. In architecture, even the most ethereal philosophical and scientific references generally correspond to concrete stakes. A first answer could lie in the desire to be in tune with the various forces and fields revealed by processes like globalization. ILL 10 Instead of rebelling against these forces and fields, one has to accept their ineluctability, an acceptance that could eventually lead to their subversion from inside. This desire has found one of its most striking expressions in Koolhaas' theoretical production, in his essay on the "generic city" in particular.[19] In many cases, it was deemed synonymous with a new materialism repudiating all traces of dualism between mind and matter or between object and subject, a position epitomized by Sanford Kwinter's writings.[20]

More recently, the quest for sustainability has further invigorated this conception. From carbon emissions to the policies enabling their limitation, everything appears more and more continuously linked on the "blue planet," a continuity bordering redundancy that gives its full relief to Sloterdijk's philosophy of interiority. It is in such a context that the possibility of a strong continuity between subject and object, or human and non-human, to use one of Latour's favorite oppositions, has been reframed.

---

[17] On the seminal role played by Bateson, see Céline Lafontaine, *L'Empire Cybernétique. Des Machines à Penser à la Pensée Machine* (Paris, Le Seuil, 2004).

[18] William J. Mitchell, *Me++: The Cyborg Self and the Networked City* (Cambridge, Massachusetts: MIT Press, 2003).

[19] Rem Koolhaas, "La Ville générique", in R. Koolhaas et al., *Mutations* (Bordeaux: Actar, 2001).

[20] See for instance Sanford Kwinter, *Far from Equilibrium. Essays on Technology and Design Culture* (Barcelona, New York: Actar, 2008).

For digital designers, a continuous real is also important insofar that it provides the foundation for phenomena like complexity and emergence. Complexity, often equated with non linearity, is among the key characteristics of the systems these designers are interested in. In most of these systems, complexity goes with the property of emergence. Michael Hensel, Achim Menges, and Michael Weinstock define emergence as "an explanation of how natural systems have evolved and maintained themselves, and a set of models and processes for the creation of artificial systems that are designed to produce forms,"[21] appears full of promises. Through the use of the computer, designers try to emulate the capacity of natural systems to generate visible order. Emergence appears all the more enticing in that it seems profoundly non-contingent. In search of the justification of the forms that appear on their screens, digital architects can be tempted to present them as the result of a self-explanatory process of emergence.

Besides Deleuze, Whitehead is among the philosophical references often mobilized to account for the accent put on complexity and emergence. Whitehead indeed saw the world as founded on processes rather than substances.[22] In such a perspective, that Kwinter and others like to characterize as a new and radical materialism, emergence appears as a fundamental property shared by both nature and design.

THE DANGERS OF MAGIC

The real, as we have outlined it, is full of seduction with its invisible fields and gradients and its constant processes of creation. But at the same time it presents a number of risks that are far from negligible. The first has to do with its estrangement from ordinary

[21] Michael Hensel, Achim Menges, Michael Weinstock, "Emergence in Architecture", in Michael Hensel, Achim Menges, Michael Weinstock (eds.), "Emergence: Morphogenetic Design Strategies", *Architectural Design*, May-June 2004, p. 6-9, p. 6 in particular.
[22] Alfred North Whitehead, *Process and Reality: An Essay on Cosmology* (Cambridge, 1929, new edition New York: Free Press, 1978).

reality. Even if nature is ultimately composed of processes, we still live our everyday lives in a very substantial world.

This distance is often accompanied by the confused feeling that there is something distinctively magical in the digital realm. Emergent patterns and forms possess this magic turn. More generally, from the inexplicable system freezes that plague computer users to the unforeseeable figures that appear on screens, the digital seems inseparable from all kinds of magic-like occurrences and events. This magic character is reinforced by the almost superstitious behaviors that tend to develop as possible answers to these occurrences and events, like irrational typing and toggling to restart the machine or ritualistic variations upon a sequence of actions the results of which have not been understood but look profoundly satisfying. In other words, confronted with the digital world, we do not only use software and scripts, but also recipes and even spells. As for computers and networks themselves, they are certainly not as transparent as their promoters would like us to believe. The depositories of long-forgotten information lost in their various layers like books inadvertently displaced in the stacks of a giant library, they are prone to behaviors explicable only because of this subliminal digital memory. In other words, they are haunted, let the ghosts be prior software versions or unerased former users' preferences.

A magic world is a world which tends to prefer myth to history. It is striking to observe how digital architecture is generally oblivious to the historical dimension, as if the men or women it was meant for lived in an eternal present. The lack of clear historical perspective finds its counterpart in the confused feeling that we have entered a new enchanted realm placed under the aegis of fundamental myths like the alleged collapse of distance caused by electronic communication.[23] In addition to all the mysteries that we are confronted with in our everyday use of computers and networks, so many journals and books entertain us with the miracles of the digital age – the latest being

[23] See for instance Vincent Mosco, *The Digital Sublime. Myth, Power and Cyberspace* (Cambridge, Massachusetts: MIT Press, 2004).

about what generalized connectivity, social networks and blogging can achieve, like true democracy and generalized authorship – that it is hard to resist the impression of magic.

Of course, it would be a pity to discard it entirely. Like childhood, with which it is often associated, magic offers unique gratifications. One of the contributions of a discipline like architecture may very well be to conjure its dangers while preserving the core of its enchantment. In order to achieve that goal, digital architecture may have to point simultaneously at the new real that it is currently exploring and to a more traditional reality that is, at least on a purely theoretical level, discrepant with it.

TRANFIGURING REALITY

Architecture is used to this type of challenge. Among the complexities of innovative design, one finds, for instance, the necessity of accomodating present uses while paving the way for a different life. Another way of putting it is that architecture has both to do with ideology, the purpose of which is to stabilize existing social practices and systems of beliefs, and with utopia, that proposes radical alternatives to them. The duality reality/real functions in a similar way. On the one hand, the architectural discipline has to negotiate with the frame of everyday experience; on the other hand, it has to challenge it in order to answer the call of the real. Let me note in passing that the tension between reality and the real has something to do with the question of the virtual. As a call for a more profound take on the world than what common sense considers tangible reality, the real represents a promise, a virtuality.

Now, today is certainly not the first time that this tension has been felt in the architectural realm. The Vitruvian tradition was already marked by the gap between the needs and uses of the early modern inhabitants of Europe and the Greco-Roman principles exposed in the *Ten Books on Architecture*. This gap explained how

Renaissance and Baroque architects could simultaneously follow the building techniques and dispositions of their respective times and countries while claiming to obey rules elaborated some fifteen hundred years before in a totally different context. Although the Vitruvian principles of order and proportion have often been interpreted as a set of static recipes, they represented, in fact, a factor of evolution for early modern architecture. Their very distance from everyday technical and dispositional recipes created a space for innovative combinations. More generally, like utopia, the real is on the side of change in the name of an order of things that goes deeper than everyday customs.

The analogy between this type of tension and the opposition between ideology and utopia should not lead, because of the bad reputation usually attached to ideology, to the disparagement of reality in favor of the quest for the real. Architecture's adhesion to reality represents an essential part of its identity. It anchors it to the material world with the specific qualities of weight, opacity and inertia. In other words, architecture cannot only serve the cause of change; it also has to resist movement. Somewhat paradoxically, it is this very resistance that enables it to act. Without reality, architecture would be lost in the realm of speculation instead of being connected to action, to the concrete transformation of the environment as it is.

In such a perspective, the role of the quest for the real could be to transfigure reality, so that its potential for change shows through its apparently immutable features. In the case of digital architecture, the problem is not only to announce the advent of a strangely continuous world, full of fascinating properties like complexity and emergence. It is also to reconcile this world with the categories of everyday experience, beginning with the feeling we still have to be distinct from our surroundings, to be a person in the traditional sense rather than a network of stimuli and affects.

In one of his books, the American novelist Richard Powers engages this very question of the reconciliation between the traditional and the emerging visions of the self. Confronted with an enigmatic case of mental disorder, one of the protagonists of the novel, a psychiatrist named Weber, engages in a meditation on the way science understands the brain.

"He knew the drill: throughout history, the brain had been compared to the highest prevailing level of technology: steam engine, telephone switchboard, computer. Now, as Weber approached his own professional zenith, the brain became the Internet, a distributed network, more than two hundred modules in loose, mutually modifying chatter with other modules." Recognizing how disconcerting such a vision may appear even to a specialist of the subject, Powers goes on: "Some of Weber's tangled subsystems bought the model: others wanted more. Now that the modular theory had gained ascendancy over most brain thinking, Weber drifted back to his origins. In what would surely be the final stage of his intellectual development, he now hoped to find, in the latest solid neuroscience, processes that looked like old depth psychology: repression, sublimation, denial, transference. Find them at some level *above* the module."[24]

Beyond its enthusiastic endorsement of the new world of fields, gradients and flows that both surrounds and penetrates the contemporary subject, one of the most urgent tasks awaiting digital architecture might have to do with the reinvention of fundamentals that could make sense in ordinary life, helping individuals and groups to reconstruct a coherent identity.

[24] Richard Powers, *The Echo Maker* (New York: Picador, 2006), p. 190.

Antoine Picon is a Professor and Co-Director of Doctoral Programs at Harvard University's Graduate School of Design. He teaches courses in the history of architecture and technology. Trained as an engineer, architect, and historian of science and art, Picon is best known for his work in the history of architectural technologies from the eighteenth century to the present. He is author of numerous books including, *Claude Perrault (1613-1688) ou la curiosité d'un classique* (1988), *French Architects and Engineers in the Age of Enlightenment* (1988; English translation, 1992), *L'Invention de L'ingénieur moderne, L'Ecole des Ponts et Chaussées 1747-1851* (1992), *La ville territoire des cyborgs* (1998), *Les Saint-Simoniens: Raison, Imaginaire, et Utopie* (2002), *Tra utopia e ruggine, Paesaggi dell'ingegneria dal Settecento a oggi* (2006), *Marc Mimram Architect-Engineer: Hybrid* (2007). Most recently he has completed a book on digital architecture that will be published by Birkhäuser in 2010.